PATENT
Attorney Docket No. 07057.0105

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	)
	)
Kiyohito MURATA	) Group Art Unit: 1795
	)
Application No.: 10/540,975	) Examiner: John C. BALL
	)
Filed: June 27, 2005	)
	)
For: EXHAUST HEAT POWER GENERATION APPARATUS	) Confirmation No.: 9214
	)
	)
	)

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

DECLARATION UNDER 37 C.F.R. § 1.132

I, Kiyohito Murata, do hereby make the following declaration:

1. My name is Kiyohito Murata, and I have a Master's Degree in the field of Engineering from Kyoto University in Kyoto city, Japan. I am employed by Toyota Jidosha Kabushiki Kaisha. I worked in the Future Project Division, where I was engaged for 7 years in research and development of regeneration of heat loss (at the time of filing of the international patent application). Currently, I work in to the Advanced Power Train Engineering Dept., where I have been engaged for 4 years in research and development of new power trains. I am very familiar with the field of mechanical engineering, and particularly with exhaust heat power generation apparatus.

2. I have read and understand the specification, drawings, and claims of U.S. Patent Application No. 10/540,975 ("the '975 application") directed to an exhaust heat power generation apparatus. I also have read and understand "Modulus of Rigidity from the Engineering Tool Box," http://www.engineeringtoolbox.com/modulus-rigidity-d_946.html.

3. "Modulus of rigidity" is a ratio of shear stress to displacement per unit sample length of a material. Modulus of rigidity relates to shearing force and usually is measured in GPa (gigapascals) or ksi (thousands of pounds per square inch).

4. "Rigidity," in contrast, is the relative stiffness of components sharing a load and indicates how much stronger one component is in comparison to another. Rigidity is related to the dimensions of a component and its tensile and compressive normal stresses. Rigidity values have no units.

5. The modulus of rigidity of components sharing a load does not factor into a calculation of rigidity. Accordingly, because the rigidity and modulus of rigidity of a component are not related, one cannot determine the rigidity of components merely by knowing the modulus of rigidity of the materials making up such components.

6. The exhaust heat power generation apparatus recited in claim 1 of the '975 application recites, among other things, a thermoelectric converting unit having a first value of rigidity; a heat exchange unit having a second value of rigidity; and a cooling unit having a third value of rigidity. The third value of rigidity is higher than the first and second values of rigidity. The claimed values of rigidity are not dependent on the modulus of rigidity of the components.

7. It would not have been obvious to one of ordinary skill in the art, therefore, to arrive at the claimed relative rigidities of the thermoelectric converting unit, the heat exchange unit, and the cooling unit, as recited in claim 1, merely by knowing the modulus of rigidity of the three components.

8. All statements made herein of my own knowledge are true and all statements made on information and belief are believed to be true. These statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Dated: June 23, 2009

By: Kiyohito Murata
Kiyohito Murata

1. BASIC CONCEPTS

Strength of materials (known also as *mechanics of materials*) deals with the elastic behavior of loaded engineering materials.[1] This subject draws heavily on the topics in Chaps. 46 and 48.

Stress is force per unit area, F/A. Typical units of stress are lbf/in^2, ksi (thousands of pounds per square inch), and MPa. Although there are many names given to stress, there are only two primary types, differing in the orientation of the loaded area. With *normal stress*, σ, the area is normal to the force carried. With *shear stress*, τ, the area is parallel to the force.

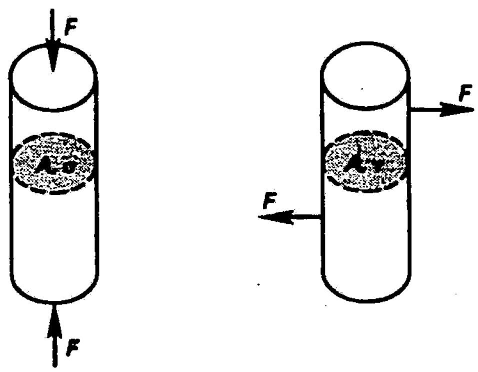


Figure 49.1 Normal and Shear Stress

Strain, ϵ, is elongation expressed on a fractional or percentage basis. It may be listed as having units of in/in, mm/mm, and percent, or no units at all. A strain in one direction will be accompanied by strains in orthogonal directions in accordance with Poisson's ratio. *Dilation* is the sum of the strains in the three coordinate directions.

$$\text{dilation} = \epsilon_x + \epsilon_y + \epsilon_z \qquad 49.1$$

2. HOOKE'S LAW

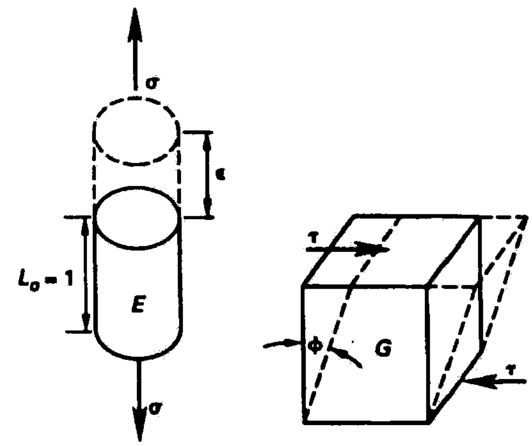
Hooke's law is a simple mathematical statement of the relationship between elastic stress and strain: Stress is proportional to strain. For normal stress, the constant of proportionality is the *modulus of elasticity* (*Young's modulus*), E.

$$\sigma = E\epsilon \qquad 49.2$$

For shear stress, the constant of proportionality is the *shear modulus*, G.

$$\tau = G\phi \qquad 49.3$$

[1]Plastic behavior and ultimate strength design are not covered in this book.



(a) normal stress (b) shear stress

Figure 49.2 Application of Hooke's Law

3. ELASTIC DEFORMATION

Since stress is F/A and strain is δ/L_o, Hooke's law can be rearranged in form to give the elongation of an axially loaded member with a uniform cross section experiencing normal stress. Tension loading is considered positive; compressive loading is negative.

$$\delta = L_o\epsilon = \frac{L_o\sigma}{E} = \frac{L_oF}{EA} \qquad 49.4$$

The actual length of a member under loading is given by Eq. 49.5. The algebraic sign of the deformation must be observed.

$$L = L_o + \delta \qquad 49.5$$

4. TOTAL STRAIN ENERGY

The energy stored in a loaded member is equal to the work required to deform the member. Below the proportionality limit, the total *strain energy* for a member loaded in tension or compression is given by Eq. 49.6.

$$U = \tfrac{1}{2}F\delta = \frac{F^2L_o}{2AE} = \frac{\sigma^2L_oA}{2E} \qquad 49.6$$

5. STIFFNESS AND RIGIDITY

Stiffness is the amount of force required to cause a unit of deformation (displacement) and is often referred to as a *spring constant*. Typical units are pounds per inch and newtons per meter. The stiffness of a spring or other structure can be calculated from the deformation equation by solving for F/δ. Equation 49.7 is valid for tensile and compressive normal stresses. For torsion and bending, the stiffness equation will depend on how the deflection is calculated.

$$k = \frac{F}{\delta} \quad \text{[general form]} \qquad 49.7(a)$$

$$= \frac{AE}{L_o} \quad \text{[normal stress form]} \qquad 49.7(b)$$

When more than one spring or resisting member share the load, the relative stiffnesses are known as *rigidities*. Rigidities have no units, and the individual rigidity values have no significance. A ratio of two rigidities, however, indicates how much stronger one member is compared to another. Equation 49.8 is one method of calculating rigidity in a multi-member structure. (Since rigidities are relative numbers, they can be multiplied by the least common denominator to obtain integer values.)

$$R_j = \frac{k_j}{\sum_i k_i} \qquad 49.8$$

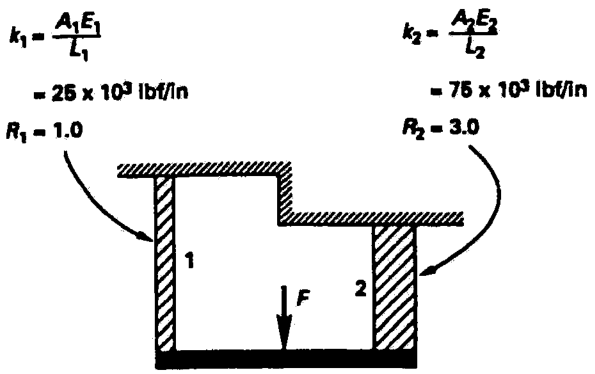


Figure 49.3 *Stiffness and Rigidity*

Rigidity is the reciprocal of deflection. *Flexural rigidity* is the reciprocal of deflection in members that are acted upon by a moment (i.e., are in bending), although that term may also be used to refer to the product, EI, of the modulus of elasticity and the moment of inertia.

6. THERMAL DEFORMATION

If the temperature of an object is changed, the object will experience length, area, and volume changes. The magnitude of these changes will depend on the *coefficient of linear expansion*, α, which is widely tabulated for solids. *The coefficient of volumetric expansion*, β, is encountered less often for solids but is used extensively with liquids and gases.

$$\Delta L = \alpha L_o(T_2 - T_1) \qquad 49.9$$

$$\Delta A = \gamma A_o(T_2 - T_1) \qquad 49.10$$

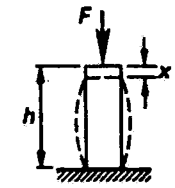
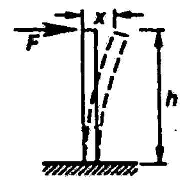
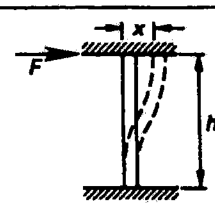
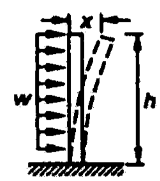
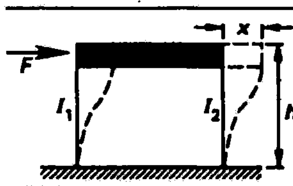
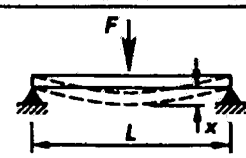
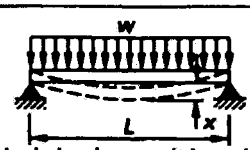
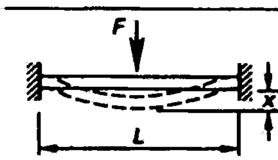
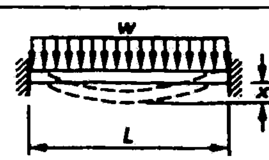
$$\gamma \approx 2\alpha \qquad 49.11$$

$$\Delta V = \beta V_o(T_2 - T_1) \qquad 49.12$$

$$\beta \approx 3\alpha \qquad 49.13$$

It is a common misconception that a hole in a plate will decrease in size when the plate is heated (because the surrounding material "squeezes in" on the hole). However, changes in temperature affect all dimensions the same way. In this case, the circumference of the hole is a linear dimension that follows Eq. 49.9. As the circumference increases, the hole area also increases.

Table 49.1 *Deflection and Stiffness for Various Systems (due to bending moment alone)*

system	maximum deflection (x)	stiffness (k)
	$\frac{Fh}{AE}$	$\frac{AE}{h}$
	$\frac{Fh^3}{3EI}$	$\frac{3EI}{h^3}$
	$\frac{Fh^3}{12EI}$	$\frac{12EI}{h^3}$
	$\frac{wL^4}{8EI}$	$\frac{8EI}{L^3}$
	$\frac{Fh^3}{12E(I_1+I_2)}$	$\frac{12E(I_1+I_2)}{h^3}$
	$\frac{FL^3}{48EI}$	$\frac{48EI}{L^3}$
 (w is load per unit length)	$\frac{5wL^4}{384EI}$	$\frac{384EI}{5L^3}$
	$\frac{FL^3}{192EI}$	$\frac{192EI}{L^3}$
 (w is load per unit length)	$\frac{wL^4}{384EI}$	$\frac{384EI}{L^3}$